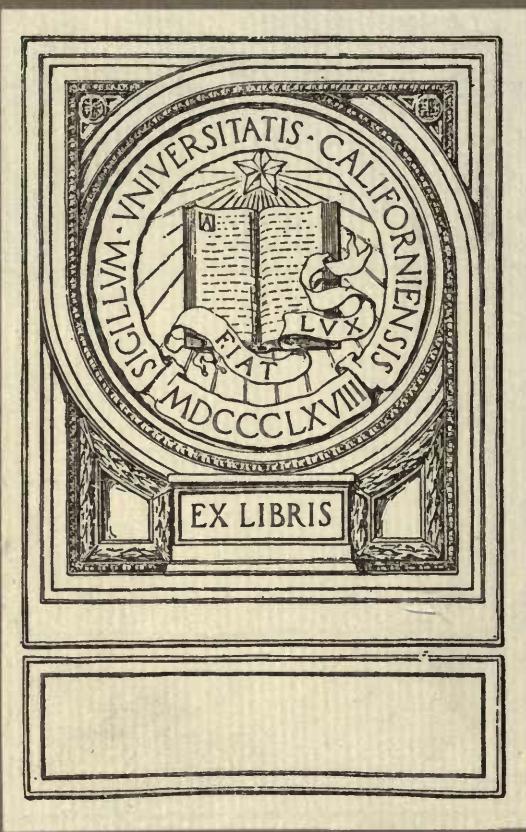
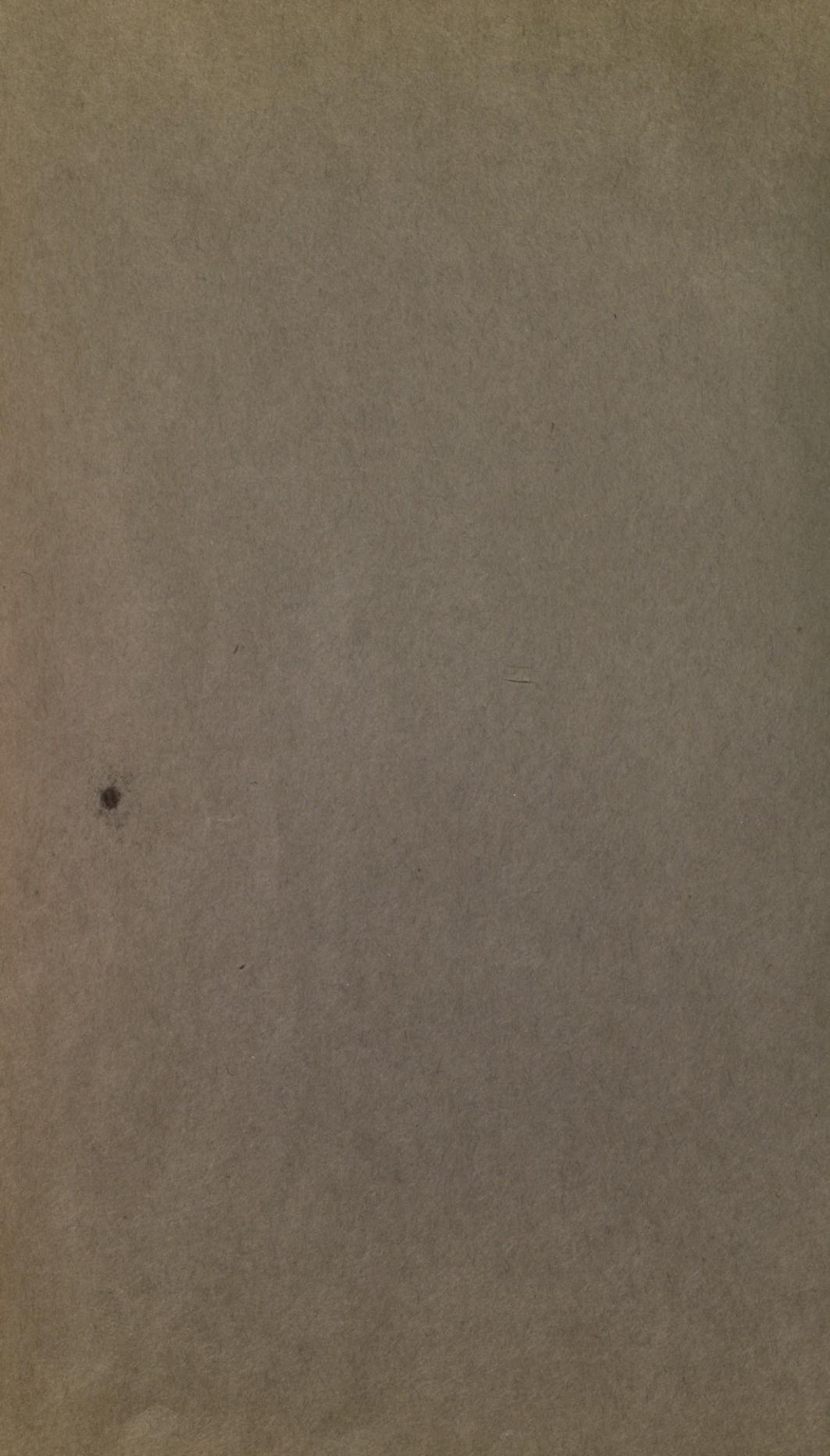


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A Ph.D. Thesis by
Thomas Erwin Phipps

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THE CONDUCTANCE OF CERTAIN ALKALI METALS IN LIQUID

AMMONIA AND IN METHYLAMINE

Deposited in the Library Sept. 17, 1921. J. C. Howell, Lib. Eng.

The photometric investigation by Gibson and Argo¹ of the blue solutions of several alkali and alkaline earth metals in liquid ammonia and in methylamine led to identical absorption curves in liquid ammonia, but to more complex ones in methylamine. The hypothesis was advanced that in liquid ammonia the dissociation of the metal into electrons is nearly complete, and that the solvation of these electrons is nearly complete; whereas in methylamine the concentration of the unionized metal is considerable, and the solvation of the electrons is incomplete. The most promising method of studying the interesting questions of ionization and solvation appeared to be in determining the temperature coefficients of conductivity of the blue solutions in liquid ammonia and in methylamine.

Since liquid ammonia was more available than methylamine, it was used as solvent in all earlier experiments, and later when the manipulation was well established, solutions in methylamine were studied. While the investigation was in progress, the recent comprehensive study by Kraus² of conductances in liquid ammonia was published, and his results are confirmed at several points by our own.

¹ Gibson and Argo, Phys. Rev., 1, 33 (1916);
This Journal, 40, 1327 (1916).

²

Kraus, This Journal, 43, 749 (1921).

THE CONDENSATION OF CERTAIN ALKALI METALS IN PLIQUID

THE INFORMATION IN THE ATTACHMENT

Stil und als verhältnis gerichtet an die Kultur

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Krasa, The Journey, 1996 (last).

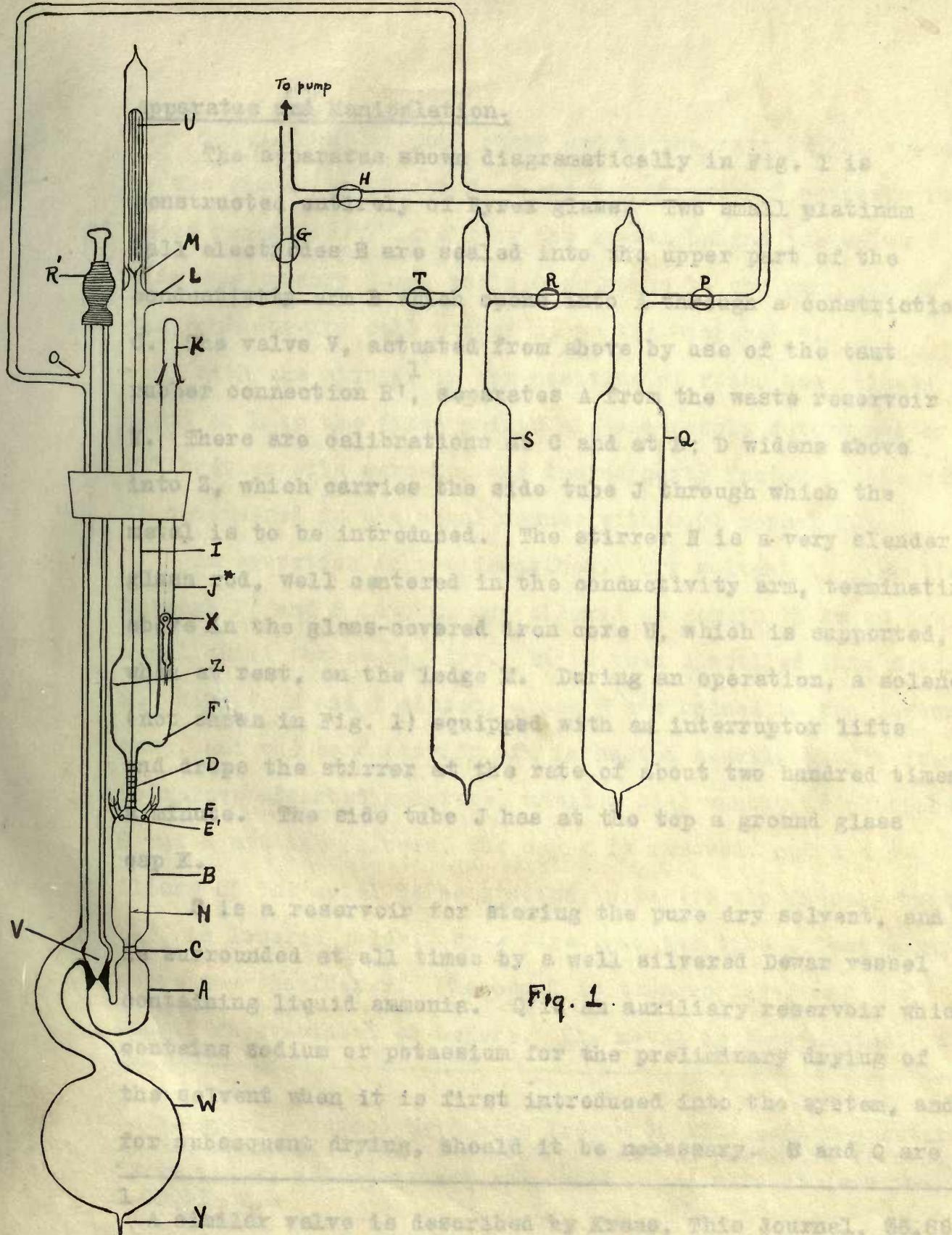
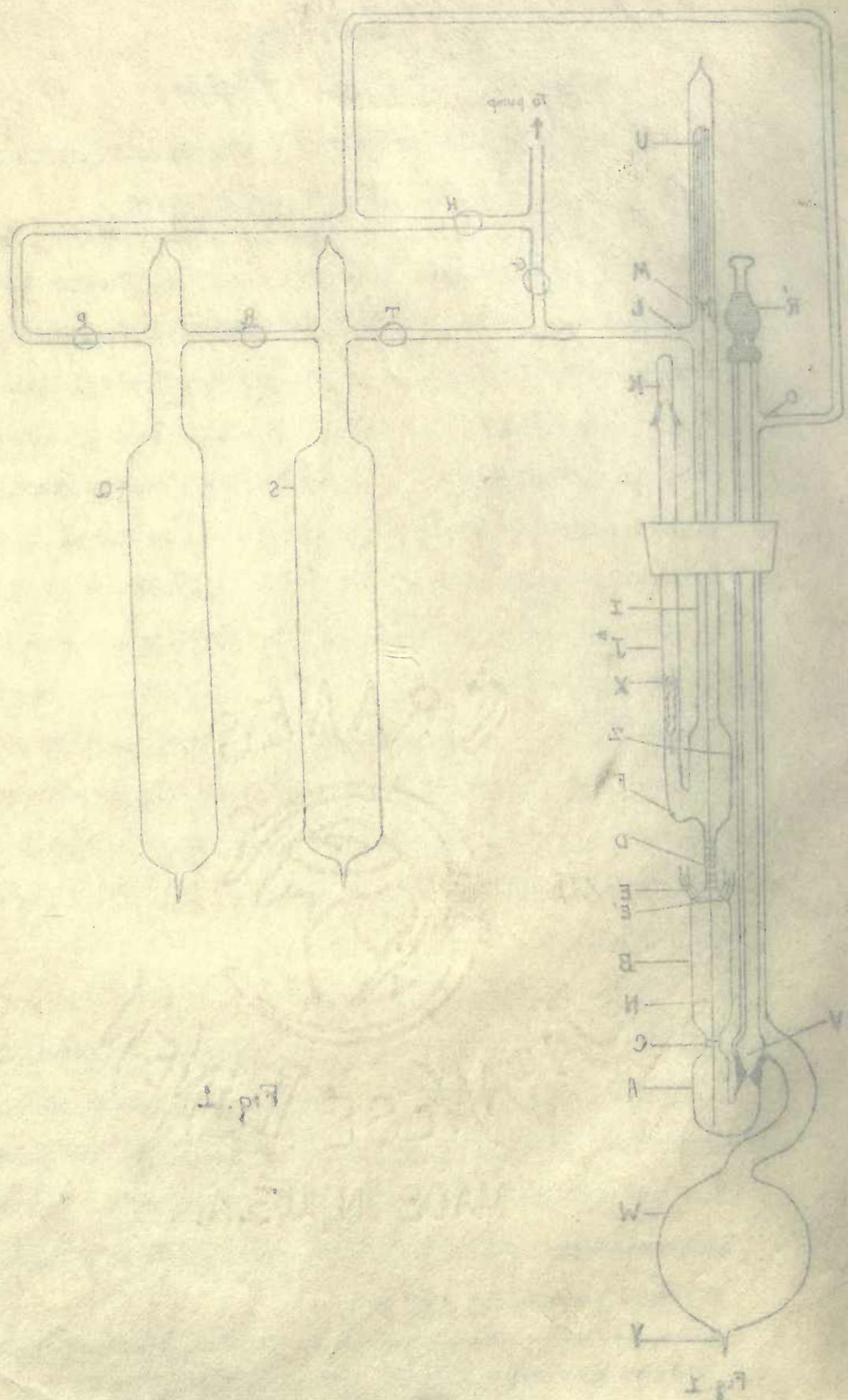


Fig. 1

* The side-tube J enters Z at a point higher than that shown in the figure.



Apparatus and Manipulation.

The apparatus shown diagrammatically in Fig. 1 is constructed entirely of Pyrex glass. Two small platinum ball electrodes E are sealed into the upper part of the conductivity arm B which opens into A through a constriction C. The valve V, actuated from above by use of the taut rubber connection R¹, separates A from the waste reservoir W. There are calibrations at C and at D; D widens above into Z, which carries the side tube J through which the metal is to be introduced. The stirrer N is a very slender glass rod, well centered in the conductivity arm, terminating above in the glass-covered iron core U, which is supported, when at rest, on the ledge M. During an operation, a solenoid (not shown in Fig. 1) equipped with an interruptor lifts and drops the stirrer at the rate of about two hundred times a minute. The side tube J has at the top a ground glass cap K.

S is a reservoir for storing the pure dry solvent, and is surrounded at all times by a well silvered Dewar vessel containing liquid ammonia. Q is an auxiliary reservoir which contains sodium or potassium for the preliminary drying of the solvent when it is first introduced into the system, and for subsequent drying, should it be necessary. S and Q are

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made independent of each other and of the rest of the system by the vacuum stopcocks T, r and P. Stopcock H connects the waste reservoir W and all of the system behind the valve V with the mercury pump, while G connects to the pump all of the conductivity cell proper up to the stopcock T.

With the stirrer in its position of rest, the volumes of A and of B to the fixed points are accurately determined by calibration with mercury, and the capacity factor of the cell is determined in the usual manner with 0.01 normal KCl.

An operation is now described. Dry solvent is distilled through P' and P into Q, and allowed to remain there on the metal until thoroughly dry. It is then distilled into S through R. With P, R and T closed, G and H are opened to the mercury pump, and the conductivity arm is heated heavily with a flame to remove adsorbed moisture, until a high vacuum is obtained.¹ G and H are then closed, the cap K is removed, and a capillary of the metal to be studied, with its tip freshly broken off, is lowered quickly by a wire into the tube J to a point above the shoulder F. The cap K is then replaced and the vessel re-evacuated as before. The metal is then melted out

¹ This regulation is very accurate. The bath is then replaced.

The spark produced by a high frequency 110v coil was entirely extinguished. When a similar condition prevailed in other Pyrex lines, McLeod guages indicated a pressure of less than 0.00001 mm.

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of the capillary by gentle heating of J, and rests as a bright globule in F, whence by further heating it is distilled, in whole or in part as desired, into the wider tube Z where it appears as a bright mirror on the walls of the glass. Potassium and caesium distill very rapidly, and even sodium distills quite readily in a very high vacuum. The slight amount of oxide which accompanied the introduction of the capillary remains in F throughout the run, and solvent is never condensed on it.

G and H are then closed, and the conductivity cell is surrounded by a bath of boiling liquid ammonia with its level at Z. Dry solvent is then distilled through T from the reservoir S, and the metal is completely washed down into A and B until the blue solution fills the vessel from the valve up to a point in D. Stirring is continued till the conductivity reaches a constant value, when the volume is read with the stirrer at rest.

To make a dilution, the bath is lowered away for a moment till its level is at C, and the valve is slightly unseated by upward tension at R' until the level of the blue solution has fallen to C. With a well ground valve this regulation is very accurate. The bath is then replaced and fresh solvent distilled in as before, with the stirrer

¹ Alcohol was not used on account of the uncertainty of the end-point when it was present.

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operating all the while. At the end of a run, which rarely required more than two hours, stopcocks H, P and R are opened and the solvent is returned by distillation from the blue solution in W to S, leaving in W all the metal which was originally present in the first solution. With the solvent isolated in S, the last trace of solvent is removed from the metal by evacuation and by slight warming of W. The tip Y is then broken, and the metal is oxidized by a stream of moist air admitted at P'. W is then washed out thoroughly, the solution is evaporated to a small volume to remove ammonia, and the solution is titrated with 0.1 normal HCl, with methyl orange as an indicator. All necessary data are now at hand for the calculation of volume-normal concentrations and specific and molecular conductivities.

To prepare the vessel for another run, the empty capillary X is withdrawn and the vessel filled through J down as far as the valve with cleaning mixture, which is then heated and allowed to stand in the vessel for several minutes. It is forced out by way of V through Y, and followed by many changes of distilled water, which is removed in the same way. Finally, with the valve clamped open, the vessel is dried thoroughly by a stream of warm air coming from P' and from K. The tips Y and P' are sealed off and the evac-

¹ Alcohol was not used on account of the uncertainty of the end-point when it was present.

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uation proceeds as before.

The filling of capillaries is as follows: tubing of small bore is constricted further, and bent at about a 60° angle at the constriction. One end of the tube is sealed off at a suitable distance from the bend, and the other end is sealed to a vacuum line. After being evacuated, the tube is sealed off at a point which leaves a symmetrical V-shape. The tip of the "v" is put below the surface of a globule of the molten metal and broken; this leaves the two tubes terminating in small capillaries entirely filled with bright clean metal. To prevent further oxidation of the metal at the tips, the capillaries are kept under oil.

The two temperatures employed in most of the experiments were the boiling point of liquid ammonia, and a temperature about 15° lower (-48.5°C), obtained by bubbling dried air at a controlled rate through the bath. By hand regulation the temperature was kept constant within 0.1°C or 0.2°C . Chloroform, frozen by means of solid carbon dioxide was used as a bath in two or three of the experiments, but its temperature was found to be quite inconstant, and because of the difficulty of making a satisfactory constant temperature bath in the neighborhood of -70.0°C ., work at the lower temperature was abandoned, although on account of slower fading it seemed desirable to work at that temperature.

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Results.

The work in liquid ammonia comprised measurements at three temperatures, -33.5°C , -48.5°C , and -70.0°C . of the conductivities of the blue solutions of sodium between concentrations of 0.4 normal and 0.0001 normal, and measurements at the first two temperatures of potassium solutions. Curves I, II and III of Fig. 2 show the specific conductance as a function of the "dilution" V , and Curves I', II' and III' show the molecular conductivity Λ as a function of V . The agreement between the different runs is good as far as 0.001 normal, but beyond that concentration the "fading" is appreciable and erratic. At -33.5°C . the highest value for $\log k$ at $\log V = 4.0$ (0.0001 normal) corresponded to a molecular conductivity of 970, which is lower than the best value of Kraus,¹ about 1000 at this dilution.

Since the concentrations dealt with here are volume-normal, whereas Kraus's concentrations were weight normal, a direct comparison of the two would involve a knowledge of the densities; or assuming the accuracy of the two sets of data, the densities could be calculated. Unfortunately our measurements do not extend into the most concentrated blue solutions where the densities are most abnormal. A careful comparison of two representative series obtained by

¹

By "fading" is meant the reaction of the metal with the solvent to form the metal amide.

² Loc. cit.

Table I

Conductance of Sodium in Liquid Ammonia

 -33.5°C.

Series I				Series II			
No.	log k	log V	Δ	No.	log k	log V	Δ
1	0.198	0.111	2038	1	2.978	0.793	591
2	1.490	0.406	787	2	2.431	1.237	466
3	1.074	0.696	587	3	2.019	1.680	501
4	2.710	0.985	495	4	3.662	2.125	613
5	2.387	1.277	461	5	3.301	2.569	742
6	2.116	1.561	475	6	4.882	3.013	786
7	2.877	1.844	526				
8	3.657	2.125	605				
9	3.422	2.419	693				
10	3.172	2.708	759				
11	4.907	2.996	799				
12	4.633	3.283	825				
13	4.354	3.576	852				

Series III				Series IV			
No.	log k	log V	Δ	No.	log k	log V	Δ
1	2.896	0.849	556	1	2.585	1.087	470
2	2.382	1.295	476	2	2.138	1.530	466
3	3.975	1.739	518	3	3.772	1.973	556
4	3.625	2.182	642	4	3.418	2.416	683
5	3.260	2.625	769	5	3.025	2.859	766
6	4.834	3.068	798	6	4.592	3.302	780
7	4.329	3.511	692	7	4.084	3.745	675

 -48.5°C.

Series V				Series VI			
No.	log k	log V	Δ	No.	log k	log V	Δ
1	1.062	0.641	505	1	1.200	0.536	545
2	2.500	1.086	386	2	2.616	0.981	396
3	2.023	1.531	358	3	2.120	1.423	349
4	3.630	1.984	412	4	3.715	1.873	388
5	3.282	2.427	512	5	3.359	2.322	480
6	4.910	2.870	603	6	4.975	2.765	550
7	4.472	3.320	620				

T. eGdeP

Geographical distribution of *Sophora* in South America

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Series A1

V. 2019

No.	log x	log y	A	No.	log x	log y	A	No.	log x	log y	A
242	0.298	0.298	1.1	250	0.298	0.298	1.1	268	0.298	0.298	1.1
288	0.281	0.281	1.1	296	0.276	0.276	1.1	306	0.266	0.266	1.1
292	0.282	0.282	1.1	310	0.270	0.270	1.1	323	0.253	0.253	1.1
366	0.243	0.243	1.1	375	0.242	0.242	1.1	386	0.230	0.230	1.1
480	0.225	0.225	1.1	495	0.215	0.215	1.1	500	0.210	0.210	1.1
550	0.215	0.215	1.1	565	0.205	0.205	1.1	574	0.204	0.204	1.1

Table I (concluded)

-48.5° C.

I-92.5° C., II-48.5° C., III-70.0° C.

Series VII

No.	log k	log V	Δ
1	2.850	0.804	451
2	2.310	1.248	361
3	3.872	1.694	368
4	3.508	2.139	444
5	3.156	2.584	550
6	4.728	3.028	570

-70.0° C.

Series VIII

No.	log k	log V	Δ
1	2.836	0.654	309
2	2.436	0.971	256
3	2.056	1.302	228
4	3.723	1.636	229
5	3.448	1.963	257
6	3.168	2.294	290
7	4.896	2.615	324
8	4.611	2.935	351
9	4.321	3.256	360

Series IX

No.	log k	log V	Δ
1	1.295	0.310	403
2	2.679	0.778	287
3	2.121	1.238	229
4	3.657	1.700	228
5	3.289	2.162	283
6	4.933	2.625	362
7	4.547	3.092	436

Table I (continued)

-49.0° C.

Series AII

Δ	No.	log k	log A	Δ
4.251	1	0.804	0.821	4.251
3.910	2	1.848	1.851	3.910
3.848	3	1.934	1.935	3.848
3.788	4	2.123	2.124	3.788
3.686	5	2.584	2.590	3.686
3.630	6	2.658	2.664	3.630
3.589	7	2.819	2.828	3.589
3.540	8	3.028	3.036	3.540

-40.0° C.

Series IX

Δ	No.	log k	log A	Δ
4.028	1	0.310	0.329	4.028
3.948	2	0.345	0.364	3.948
3.859	3	0.388	0.407	3.859
3.769	4	0.430	0.449	3.769
3.679	5	0.475	0.494	3.679
3.589	6	0.520	0.539	3.589
3.498	7	0.562	0.581	3.498
3.408	8	0.603	0.622	3.408

Series AIII

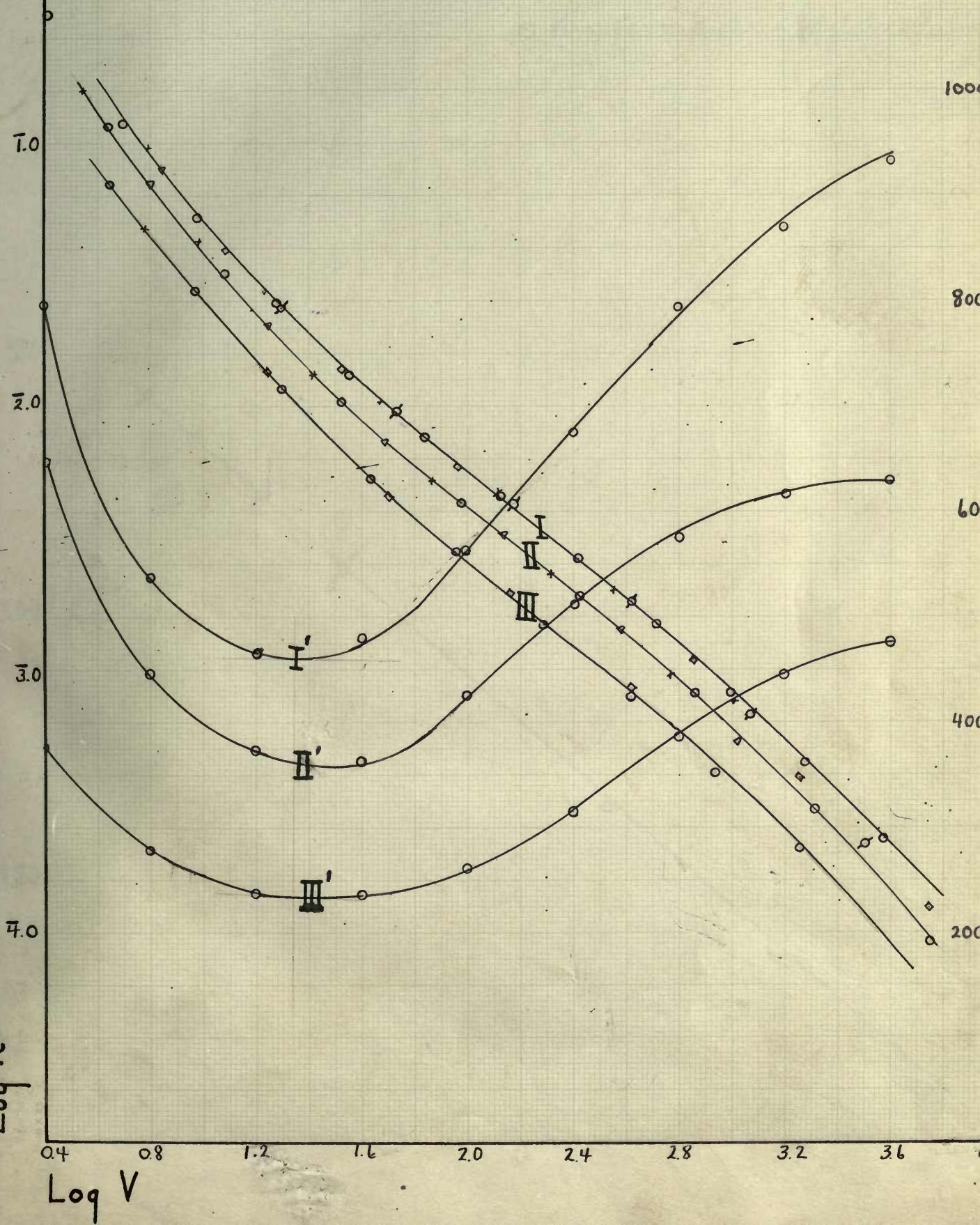
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Δ	No.	log k	log A	Δ
0.836	1	0.206	0.226	0.836
0.836	2	0.247	0.267	0.836
0.836	3	0.288	0.308	0.836
0.836	4	0.329	0.349	0.836
0.836	5	0.370	0.390	0.836
0.836	6	0.411	0.431	0.836
0.836	7	0.452	0.472	0.836
0.836	8	0.493	0.513	0.836

Fig 2

Na in NH_3

I-33.5°C; II-48.5°C; III-70.0°C.



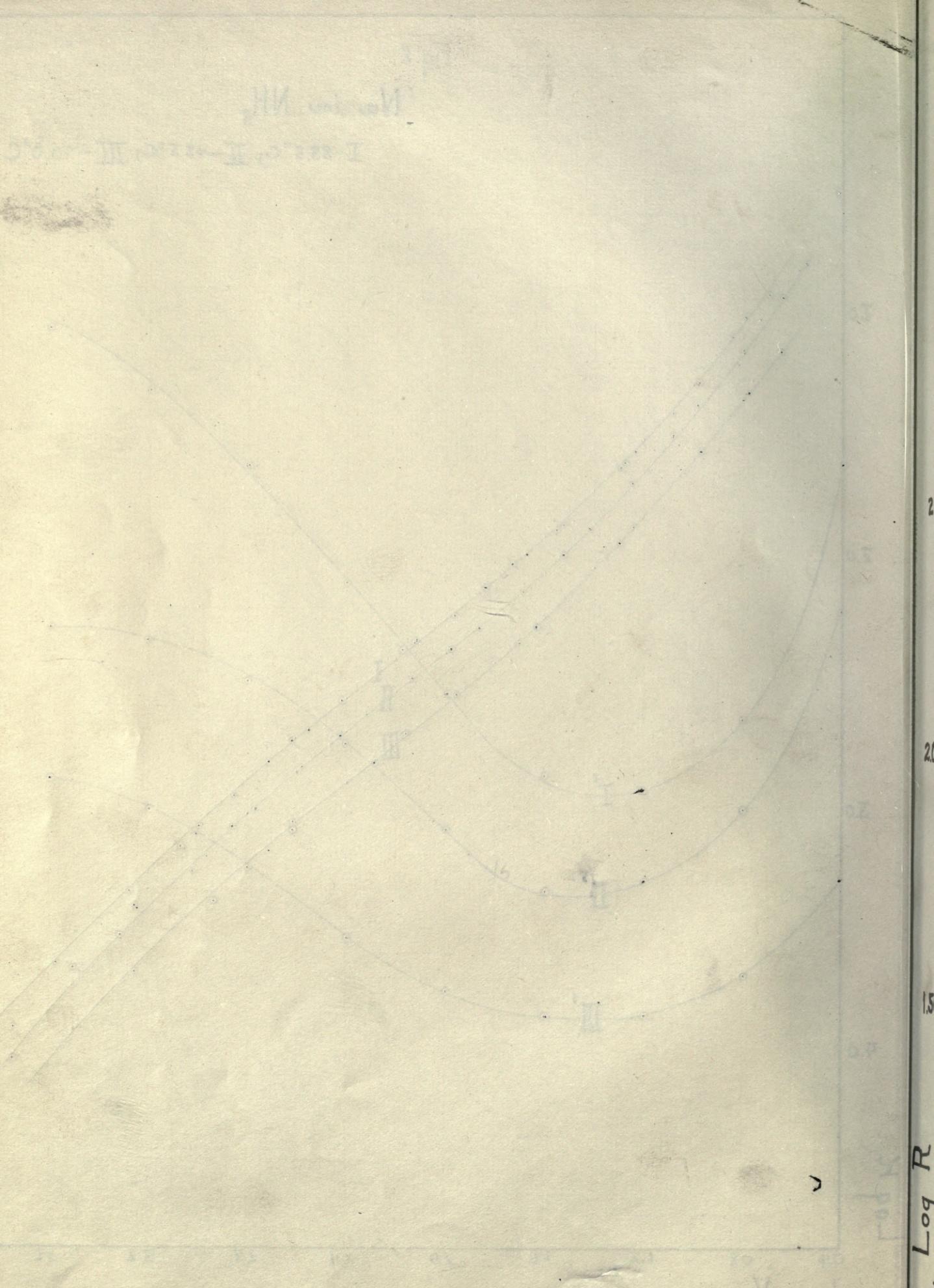
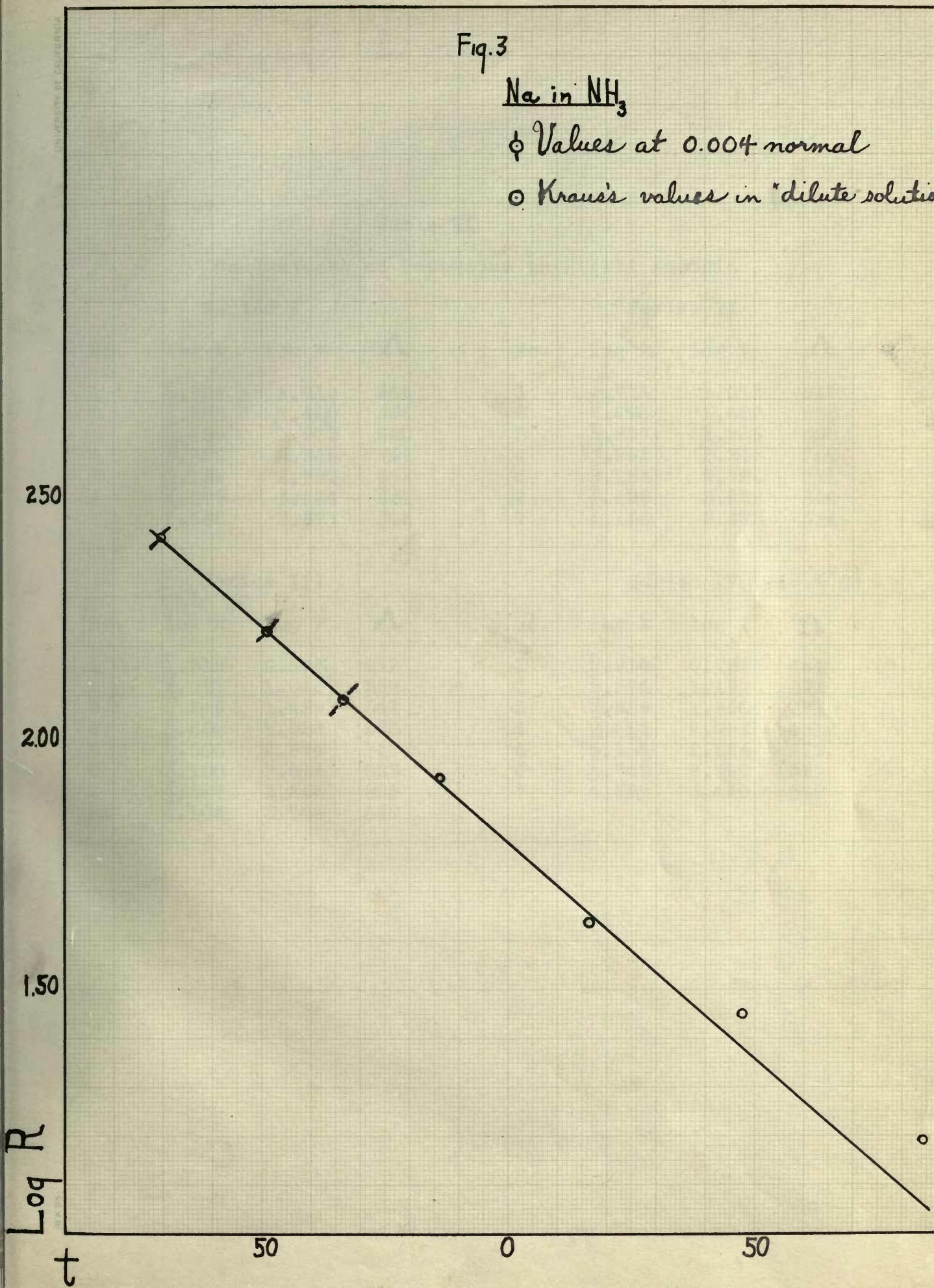


Fig. 3

Na in NH₃

ϕ Values at 0.004 normal

○ Kraus's values in "dilute solution"



Km NH₃

I-53.5°C., II-48.5°C.

Table II

Conductance of Potassium in Liquid Ammonia

Series I

No.	log k	log V	Δ
1	2.766	1.015	604
2	2.283	1.460	554
3	3.889	1.903	620
4	3.526	2.346	746
5	3.135	2.790	842
6	4.579	3.234	651
7	5.862	3.677	346

Series II

No.	log k	log V	Δ
1	2.774	1.015	615
2	2.292	1.458	563
3	3.897	1.901	628
4	3.542	2.344	769
5	3.154	2.786	871
6	4.698	3.228	844
7	4.168	3.673	694

Series III

No.	log k	log V	Δ
1	1.315	0.595	813
2	2.731	1.045	598
3	2.245	1.489	542
4	3.860	1.932	620
5	3.500	2.374	749
6	3.100	2.815	823
7	4.647	3.258	805
8	4.103	3.703	640

Series IV (-48.5°C)

No.	log k	log V	Δ
1	2.914	0.752	464
2	2.374	1.197	373
3	3.929	1.640	371
4	3.552	2.082	431
5	3.185	2.524	512
6	4.749	2.967	521
7	4.329	3.410	549

Table II

Concentrations of Potassium in Living Ammonia

Series II

Δ	No.	log κ	log A	Δ	No.	log κ	log A	Δ	No.	log κ	log A
865	4.102	3.942	802	4.253	3.910	802	5.288	3.844	200	5.244	3.844
866	4.103	3.943	803	4.254	3.911	803	5.289	3.845	201	5.245	3.845
867	4.104	3.944	804	4.255	3.912	804	5.290	3.846	202	5.246	3.846
868	4.105	3.945	805	4.256	3.913	805	5.291	3.847	203	5.247	3.847
869	4.106	3.946	806	4.257	3.914	806	5.292	3.848	204	5.248	3.848
870	4.107	3.947	807	4.258	3.915	807	5.293	3.849	205	5.249	3.849
871	4.108	3.948	808	4.259	3.916	808	5.294	3.850	206	5.250	3.850
872	4.109	3.949	809	4.260	3.917	809	5.295	3.851	207	5.251	3.851
873	4.110	3.950	810	4.261	3.918	810	5.296	3.852	208	5.252	3.852
874	4.111	3.951	811	4.262	3.919	811	5.297	3.853	209	5.253	3.853
875	4.112	3.952	812	4.263	3.920	812	5.298	3.854	210	5.254	3.854
876	4.113	3.953	813	4.264	3.921	813	5.299	3.855	211	5.255	3.855
877	4.114	3.954	814	4.265	3.922	814	5.300	3.856	212	5.256	3.856
878	4.115	3.955	815	4.266	3.923	815	5.301	3.857	213	5.257	3.857
879	4.116	3.956	816	4.267	3.924	816	5.302	3.858	214	5.258	3.858
880	4.117	3.957	817	4.268	3.925	817	5.303	3.859	215	5.259	3.859
881	4.118	3.958	818	4.269	3.926	818	5.304	3.860	216	5.260	3.860
882	4.119	3.959	819	4.270	3.927	819	5.305	3.861	217	5.261	3.861
883	4.120	3.960	820	4.271	3.928	820	5.306	3.862	218	5.262	3.862
884	4.121	3.961	821	4.272	3.929	821	5.307	3.863	219	5.263	3.863
885	4.122	3.962	822	4.273	3.930	822	5.308	3.864	220	5.264	3.864
886	4.123	3.963	823	4.274	3.931	823	5.309	3.865	221	5.265	3.865
887	4.124	3.964	824	4.275	3.932	824	5.310	3.866	222	5.266	3.866
888	4.125	3.965	825	4.276	3.933	825	5.311	3.867	223	5.267	3.867
889	4.126	3.966	826	4.277	3.934	826	5.312	3.868	224	5.268	3.868
890	4.127	3.967	827	4.278	3.935	827	5.313	3.869	225	5.269	3.869
891	4.128	3.968	828	4.279	3.936	828	5.314	3.870	226	5.270	3.870
892	4.129	3.969	829	4.280	3.937	829	5.315	3.871	227	5.271	3.871
893	4.130	3.970	830	4.281	3.938	830	5.316	3.872	228	5.272	3.872
894	4.131	3.971	831	4.282	3.939	831	5.317	3.873	229	5.273	3.873
895	4.132	3.972	832	4.283	3.940	832	5.318	3.874	230	5.274	3.874
896	4.133	3.973	833	4.284	3.941	833	5.319	3.875	231	5.275	3.875
897	4.134	3.974	834	4.285	3.942	834	5.320	3.876	232	5.276	3.876
898	4.135	3.975	835	4.286	3.943	835	5.321	3.877	233	5.277	3.877
899	4.136	3.976	836	4.287	3.944	836	5.322	3.878	234	5.278	3.878
900	4.137	3.977	837	4.288	3.945	837	5.323	3.879	235	5.279	3.879
901	4.138	3.978	838	4.289	3.946	838	5.324	3.880	236	5.280	3.880
902	4.139	3.979	839	4.290	3.947	839	5.325	3.881	237	5.281	3.881
903	4.140	3.980	840	4.291	3.948	840	5.326	3.882	238	5.282	3.882
904	4.141	3.981	841	4.292	3.949	841	5.327	3.883	239	5.283	3.883
905	4.142	3.982	842	4.293	3.950	842	5.328	3.884	240	5.284	3.884
906	4.143	3.983	843	4.294	3.951	843	5.329	3.885	241	5.285	3.885
907	4.144	3.984	844	4.295	3.952	844	5.330	3.886	242	5.286	3.886
908	4.145	3.985	845	4.296	3.953	845	5.331	3.887	243	5.287	3.887
909	4.146	3.986	846	4.297	3.954	846	5.332	3.888	244	5.288	3.888
910	4.147	3.987	847	4.298	3.955	847	5.333	3.889	245	5.289	3.889
911	4.148	3.988	848	4.299	3.956	848	5.334	3.890	246	5.290	3.890
912	4.149	3.989	849	4.300	3.957	849	5.335	3.891	247	5.291	3.891
913	4.150	3.990	850	4.301	3.958	850	5.336	3.892	248	5.292	3.892
914	4.151	3.991	851	4.302	3.959	851	5.337	3.893	249	5.293	3.893
915	4.152	3.992	852	4.303	3.960	852	5.338	3.894	250	5.294	3.894
916	4.153	3.993	853	4.304	3.961	853	5.339	3.895	251	5.295	3.895
917	4.154	3.994	854	4.305	3.962	854	5.340	3.896	252	5.296	3.896
918	4.155	3.995	855	4.306	3.963	855	5.341	3.897	253	5.297	3.897
919	4.156	3.996	856	4.307	3.964	856	5.342	3.898	254	5.298	3.898
920	4.157	3.997	857	4.308	3.965	857	5.343	3.899	255	5.299	3.899
921	4.158	3.998	858	4.309	3.966	858	5.344	3.900	256	5.300	3.900
922	4.159	3.999	859	4.310	3.967	859	5.345	3.901	257	5.301	3.901
923	4.160	4.000	860	4.311	3.968	860	5.346	3.902	258	5.302	3.902
924	4.161	4.001	861	4.312	3.969	861	5.347	3.903	259	5.303	3.903
925	4.162	4.002	862	4.313	3.970	862	5.348	3.904	260	5.304	3.904
926	4.163	4.003	863	4.314	3.971	863	5.349	3.905	261	5.305	3.905
927	4.164	4.004	864	4.315	3.972	864	5.350	3.906	262	5.306	3.906
928	4.165	4.005	865	4.316	3.973	865	5.351	3.907	263	5.307	3.907
929	4.166	4.006	866	4.317	3.974	866	5.352	3.908	264	5.308	3.908
930	4.167	4.007	867	4.318	3.975	867	5.353	3.909	265	5.309	3.909
931	4.168	4.008	868	4.319	3.976	868	5.354	3.910	266	5.310	3.910
932	4.169	4.009	869	4.320	3.977	869	5.355	3.911	267	5.311	3.911
933	4.170	4.010	870	4.321	3.978	870	5.356	3.912	268	5.312	3.912
934	4.171	4.011	871	4.322	3.979	871	5.357	3.913	269	5.313	3.913
935	4.172	4.012	872	4.323	3.980	872	5.358	3.914	270	5.314	3.914
936	4.173	4.013	873	4.324	3.981	873	5.359	3.915	271	5.315	3.915
937	4.174	4.014	874	4.325	3.982	874	5.360	3.916	272	5.316	3.916
938	4.175	4.015	875	4.326	3.983	875	5.361	3.917	273	5.317	3.917
939	4.176	4.016	876	4.327	3.984	876	5.362	3.918	274	5.318	3.918
940	4.177	4.017	877	4.328	3.985	877	5.363	3.919	275	5.319	3.919
941	4.178	4.018	878	4.329	3.986	878	5.364	3.920	276	5.320	3.920
942	4.179	4.019	879	4.330	3.987	879	5.365	3.921	277	5.321	3.921
943	4.180	4.020	880	4.331	3.988	880	5.366	3.922	278	5.322	3.922
944	4.181	4.021	881	4.332	3.989	881	5.367	3.923	279	5.323	3.923
945	4.182	4.022	882	4.333	3.990	882	5.368	3.924	280	5.324	3.924
946	4.183	4.023	883	4.334	3.991	883	5.369	3.925	281	5.325	3.925
947	4.184	4.024	884	4.335	3.992	884	5.370	3.926	282	5.326	3.926
948	4.185	4.025	885	4.336	3.993	885	5.371	3.927	283	5.327	3.927
949	4.186	4.026	886	4.337	3.994	886	5.372	3.928	284	5.328	3.928
950	4.187	4.027	887	4.338	3.995	887	5.373	3.929	285	5.329	3.929
951	4.188	4.028	888	4.339	3.996	888	5.374	3.930	286	5.330	3.930
952	4.189	4.029	889	4.340	3.997	889	5.375	3.931	287	5.331	3.931
953	4.190	4.030	890	4.341	3.998	890	5.376	3.932	288	5.332	3.932
954	4.191	4.031	891	4.342	3.999	891	5.377	3.933	289	5.333	3.933
955	4.192	4.032	892	4.343	4.000	892	5.378	3.934	290	5.334	3.934
956	4.193	4.033	893	4.344	4.001	893	5.379	3.935	291	5.335	3.935
957	4.194	4.034	894	4.345	4.002	894	5.380	3.936	292	5.336	3.936
958	4.195	4.035	895	4.346	4.003	895	5.381	3.937	293	5.337	3.937
959	4.196	4.036	896	4.347	4.004	896	5.382	3.938	294	5.338	3.938
960	4.197	4.037	897	4.348	4.005	897	5.383	3.939	295	5.339	3.939
961	4.198	4.038	898	4.349	4.006	898	5.384	3.940	296	5.340	3.940
962	4.199	4.039	899	4.350	4.007	899	5.385	3.941	297	5.341	3.941
963	4.200	4.040	900	4.351	4.008	900	5.386	3.942	298		

Fig. 4.

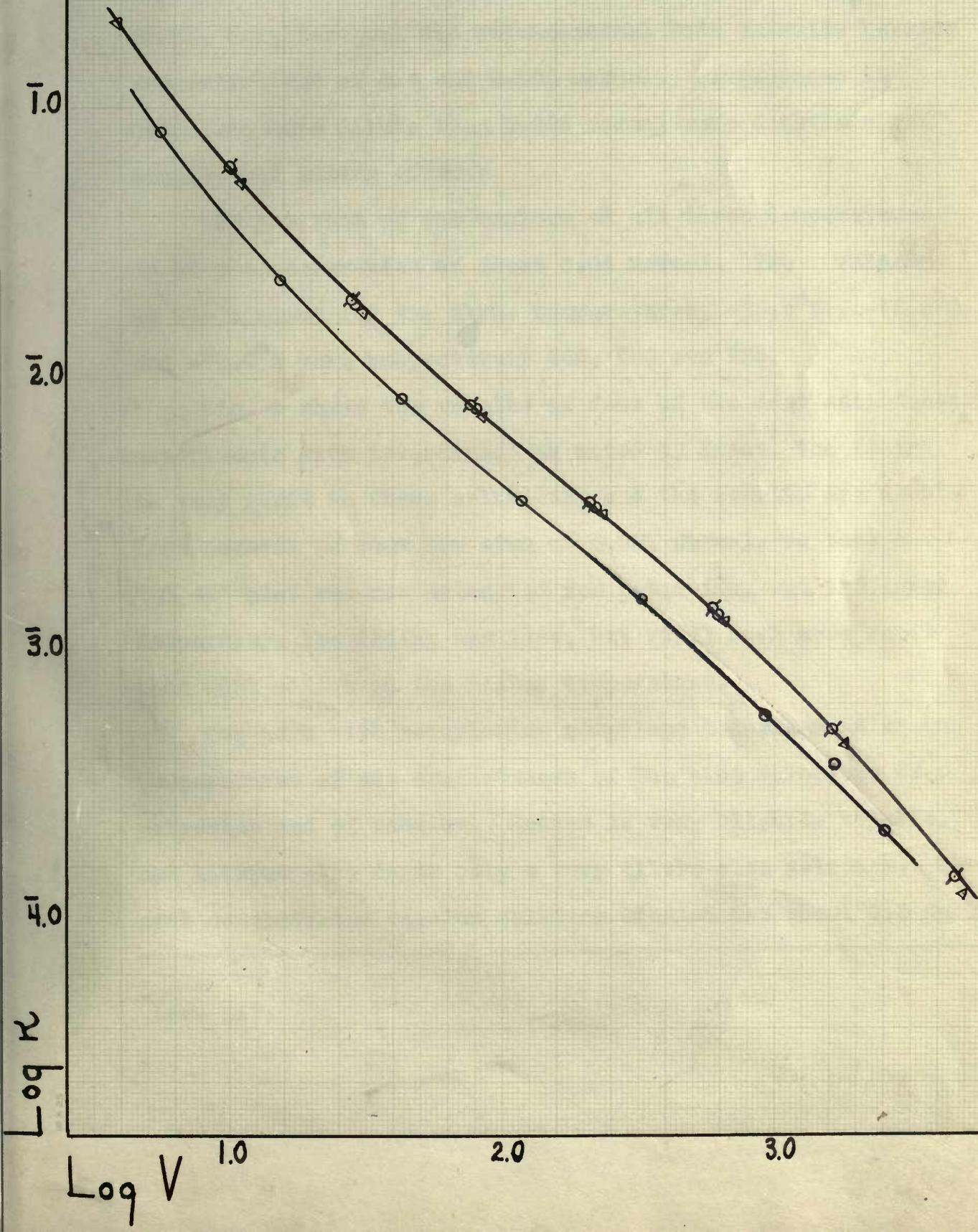
 $K \text{ in } NH_3$ I- $33.5^\circ C.$; II- $48.5^\circ C.$ 

Table III

Conductance of Sodium and Potassium Iodide in the two methods showed that within the limits of experimental error, weight-normal and volume-normal data coincide between concentrations of 0.4 and 0.005 normal. Divergences in solutions more dilute than 0.005 normal were doubtless not density but fading effects.

The position of the minimum at all three temperatures is at a concentration of about 0.04 normal. The values at the minimum for the three temperatures, $-33.5^{\circ}\text{C}.$, $-48.5^{\circ}\text{C}.$ and -70.0°C were respectively 460, 360 and 235.

Fig. 4 shows the results of four of the most satisfactory experiments with potassium. As noted by Kraus, the fading is very rapid in these solutions, and the results are doubtless several percent low even at 0.001 normal, so that a " Δ - k " plot was not attempted for potassium. At the lower temperature the fading was less, but still much more rapid than with sodium at the higher temperature.

The work with methylamine comprised measurements at two temperatures of the conductances of the blue solutions of potassium and of caesium. Sodium is very slightly soluble, and lithium also forms only a very dilute blue solution. The most concentrated caesium solution studied was about 0.3 normal.

¹
Loc. cit.

Table III

Conductance of Caesium and of Caesium Iodide in
Methylamine.

Series -33.5° C. (Caesium Iodide)

Series I				Series II			
No.	log k	log V	Δ	No.	log k	log V	Δ
1	3.556	1.145	50.3	1	2.502	10.527	67.5
2	3.160	1.591	56.4	2	3.707	10.985	49.9
3	4.839	2.035	74.9	3	3.273	21.453	53.3
4	4.529	2.476	101.2	4	4.926	21.911	68.8
	3.180	0.091	35.8	5	5.384	3.086	29.3

Series III

No.	log k	log V	Δ
1	3.048	1.728	59.7
2	4.740	2.171	81.5
3	4.418	2.620	109.2
4	4.087	3.061	140.7
5	5.703	3.503	159.6

-48.5° C.

Series IV				Series V			
No.	log k	log V	Δ	No.	log k	log V	Δ
1	3.850	0.708	36.1	1	3.691	0.880	37.3
2	3.362	1.163	33.5	2	3.233	1.325	36.2
3	3.005	1.606	40.9	3	4.897	1.768	46.3
4	4.695	2.049	55.5	4	4.577	2.212	61.6
5	4.386	2.492	75.5	5	4.257	2.653	81.3

Series VI

No.	log k	log V	Δ
1	4.588	2.233	66.3
2	4.302	2.678	95.5
3	5.972	3.125	125.1
4	5.612	3.569	151.8
5	5.187	4.011	157.8

Type III

Convergence of Gaussian Logics in
Metaparameter.

-3.5.6-

Series II

Series I

No.	log x	log A	No.	log x	log A
4.253	5.478	1.911	4.258	4.988	1.911
4.258	5.093	1.911	4.253	4.988	1.911
4.260	5.160	1.911	4.254	5.093	1.911
4.263	5.225	1.911	4.255	5.160	1.911
4.264	5.282	1.911	4.256	5.225	1.911
4.265	5.339	1.911	4.257	5.282	1.911
4.266	5.396	1.911	4.258	5.339	1.911
4.267	5.453	1.911	4.259	5.396	1.911
4.268	5.510	1.911	4.260	5.453	1.911
4.269	5.567	1.911	4.261	5.510	1.911
4.270	5.624	1.911	4.262	5.567	1.911
4.271	5.681	1.911	4.263	5.624	1.911
4.272	5.738	1.911	4.264	5.681	1.911
4.273	5.795	1.911	4.265	5.738	1.911
4.274	5.852	1.911	4.266	5.795	1.911
4.275	5.909	1.911	4.267	5.852	1.911
4.276	5.966	1.911	4.268	5.909	1.911
4.277	6.023	1.911	4.269	5.966	1.911
4.278	6.080	1.911	4.270	6.023	1.911
4.279	6.137	1.911	4.271	6.080	1.911
4.280	6.194	1.911	4.272	6.137	1.911
4.281	6.251	1.911	4.273	6.194	1.911
4.282	6.308	1.911	4.274	6.251	1.911
4.283	6.365	1.911	4.275	6.308	1.911
4.284	6.422	1.911	4.276	6.365	1.911
4.285	6.479	1.911	4.277	6.422	1.911
4.286	6.536	1.911	4.278	6.479	1.911
4.287	6.593	1.911	4.279	6.536	1.911
4.288	6.650	1.911	4.280	6.593	1.911
4.289	6.707	1.911	4.281	6.650	1.911
4.290	6.764	1.911	4.282	6.707	1.911
4.291	6.821	1.911	4.283	6.764	1.911
4.292	6.878	1.911	4.284	6.821	1.911
4.293	6.935	1.911	4.285	6.878	1.911
4.294	6.992	1.911	4.286	6.935	1.911
4.295	7.049	1.911	4.287	6.992	1.911
4.296	7.106	1.911	4.288	7.049	1.911
4.297	7.163	1.911	4.289	7.106	1.911
4.298	7.220	1.911	4.290	7.163	1.911
4.299	7.277	1.911	4.291	7.220	1.911
4.300	7.334	1.911	4.292	7.277	1.911
4.301	7.391	1.911	4.293	7.334	1.911
4.302	7.448	1.911	4.294	7.391	1.911
4.303	7.505	1.911	4.295	7.448	1.911
4.304	7.562	1.911	4.296	7.505	1.911
4.305	7.619	1.911	4.297	7.562	1.911
4.306	7.676	1.911	4.298	7.619	1.911
4.307	7.733	1.911	4.299	7.676	1.911
4.308	7.790	1.911	4.300	7.733	1.911
4.309	7.847	1.911	4.301	7.790	1.911
4.310	7.904	1.911	4.302	7.847	1.911
4.311	7.961	1.911	4.303	7.904	1.911
4.312	8.018	1.911	4.304	7.961	1.911
4.313	8.075	1.911	4.305	8.018	1.911
4.314	8.132	1.911	4.306	8.075	1.911
4.315	8.189	1.911	4.307	8.132	1.911
4.316	8.246	1.911	4.308	8.189	1.911
4.317	8.303	1.911	4.309	8.246	1.911
4.318	8.360	1.911	4.310	8.303	1.911
4.319	8.417	1.911	4.311	8.360	1.911
4.320	8.474	1.911	4.312	8.417	1.911
4.321	8.531	1.911	4.313	8.474	1.911
4.322	8.588	1.911	4.314	8.531	1.911
4.323	8.645	1.911	4.315	8.588	1.911
4.324	8.702	1.911	4.316	8.645	1.911
4.325	8.759	1.911	4.317	8.702	1.911
4.326	8.816	1.911	4.318	8.759	1.911
4.327	8.873	1.911	4.319	8.816	1.911
4.328	8.930	1.911	4.320	8.873	1.911
4.329	8.987	1.911	4.321	8.930	1.911
4.330	9.044	1.911	4.322	9.087	1.911
4.331	9.101	1.911	4.323	9.144	1.911
4.332	9.158	1.911	4.324	9.201	1.911
4.333	9.215	1.911	4.325	9.258	1.911
4.334	9.272	1.911	4.326	9.315	1.911
4.335	9.329	1.911	4.327	9.372	1.911
4.336	9.386	1.911	4.328	9.429	1.911
4.337	9.443	1.911	4.329	9.486	1.911
4.338	9.500	1.911	4.330	9.543	1.911
4.339	9.557	1.911	4.331	9.600	1.911
4.340	9.614	1.911	4.332	9.657	1.911
4.341	9.671	1.911	4.333	9.714	1.911
4.342	9.728	1.911	4.334	9.771	1.911
4.343	9.785	1.911	4.335	9.828	1.911
4.344	9.842	1.911	4.336	9.875	1.911
4.345	9.899	1.911	4.337	9.922	1.911
4.346	9.956	1.911	4.338	9.979	1.911
4.347	1.013	1.911	4.339	1.026	1.911
4.348	1.070	1.911	4.340	1.083	1.911
4.349	1.127	1.911	4.341	1.140	1.911
4.350	1.184	1.911	4.342	1.207	1.911
4.351	1.241	1.911	4.343	1.264	1.911
4.352	1.298	1.911	4.344	1.331	1.911
4.353	1.355	1.911	4.345	1.408	1.911
4.354	1.412	1.911	4.346	1.485	1.911
4.355	1.469	1.911	4.347	1.562	1.911
4.356	1.526	1.911	4.348	1.639	1.911
4.357	1.583	1.911	4.349	1.716	1.911
4.358	1.640	1.911	4.350	1.793	1.911
4.359	1.697	1.911	4.351	1.870	1.911
4.360	1.754	1.911	4.352	1.947	1.911
4.361	1.811	1.911	4.353	2.024	1.911
4.362	1.868	1.911	4.354	2.101	1.911
4.363	1.925	1.911	4.355	2.178	1.911
4.364	1.982	1.911	4.356	2.255	1.911
4.365	2.039	1.911	4.357	2.332	1.911
4.366	2.096	1.911	4.358	2.409	1.911
4.367	2.153	1.911	4.359	2.486	1.911
4.368	2.210	1.911	4.360	2.563	1.911
4.369	2.267	1.911	4.361	2.640	1.911
4.370	2.324	1.911	4.362	2.717	1.911
4.371	2.381	1.911	4.363	2.794	1.911
4.372	2.438	1.911	4.364	2.871	1.911
4.373	2.495	1.911	4.365	2.948	1.911
4.374	2.552	1.911	4.366	3.025	1.911
4.375	2.609	1.911	4.367	3.102	1.911
4.376	2.666	1.911	4.368	3.179	1.911
4.377	2.723	1.911	4.369	3.256	1.911
4.378	2.780	1.911	4.370	3.333	1.911
4.379	2.837	1.911	4.371	3.410	1.911
4.380	2.894	1.911	4.372	3.487	1.911
4.381	2.951	1.911	4.373	3.564	1.911
4.382	3.008	1.911	4.374	3.641	1.911
4.383	3.065	1.911	4.375	3.718	1.911
4.384	3.122	1.911	4.376	3.795	1.911
4.385	3.179	1.911	4.377	3.872	1.911
4.386	3.236	1.911	4.378	3.949	1.911
4.387	3.293	1.911	4.379	4.026	1.911
4.388	3.350	1.911	4.380	4.103	1.911
4.389	3.407	1.911	4.381	4.180	1.911
4.390	3.464	1.911	4.382	4.257	1.911
4.391	3.521	1.911	4.383	4.334	1.911
4.392	3.578	1.911	4.384	4.411	1.911
4.393	3.635	1.911	4.385	4.488	1.911
4.394	3.692	1.911	4.386	4.565	1.911
4.395	3.749	1.911	4.387	4.642	1.911
4.396	3.806	1.911	4.388	4.719	1.911
4.397	3.863	1.911	4.389	4.796	1.911
4.398	3.920	1.911	4.390	4.873	1.911
4.399	3.977	1.911	4.391	4.950	1.911
4.400	4.034	1.911	4.392	5.027	1.911
4.401	4.091	1.911	4.393	5.104	1.911
4.402	4.148	1.911	4.394	5.181	1.911
4.403	4.205	1.911	4.395	5.258	1.911
4.404	4.262	1.911	4.396	5.335	1.911
4.405	4.319	1.911	4.397	5.412	1.911
4.406	4.376	1.911	4.398	5.489	1.911
4.407	4.433	1.911	4.399	5.566	1.911
4.408	4.490	1.911	4.400	5.643	1.911
4.409	4.547	1.911	4.401	5.720	1.911
4.410	4.604	1.911	4.402	5.797	1.911
4.411	4.661	1.911	4.403	5.874	1.911
4.412	4.718	1.911	4.404	5.951	1.911
4.413	4.775	1.911	4.405	6.028	1.911
4.414	4.832	1.911	4.406	6.105	1.911
4.415	4.889	1.911	4.407	6.182	1.911
4.416	4.946	1.911	4.408	6.259	1.911
4.417	5.003	1.911	4.409	6.336	1.911
4.418	5.060	1.911	4.410	6.413	1.911
4.419	5.117	1.911	4.411	6.490	1.911
4.420	5.174	1.911	4.412	6.567	1.911
4.421	5.231	1.911	4.413	6.644	1.911
4.422	5.288	1.911	4.414	6.721	1.911
4.423	5.345	1.911	4.415	6.798	1.911
4.424	5.402	1.911	4.416	6.875	1.911
4.425	5.459	1.911	4.417	6.952	1.911
4.426	5.516	1.911	4.418	7.029	1.911
4.427	5.573	1.911	4.419	7.106	1.911
4.428	5.630	1.911	4.420	7.183	1.911
4.429	5.687	1.911	4.421	7.260	1.911
4.430	5.744	1.911	4.422	7.337	1.911
4.431	5.801	1.911	4.423	7.414	1.911
4.432	5.858	1.911	4.424	7.491	1.911
4.433	5.915	1.911	4.425	7.568	1.911
4.434	5.972	1.911	4.426	7.645	1.911
4.435	6.029	1.911	4.427	7.722	1.911
4.436	6.086	1.911	4.428	7.799	1.911
4.437	6.143	1.911	4.429	7.876	1.911
4.438	6.199	1.911	4.430	7.953	1.911
4.439	6.256	1.911	4.431	8.030	1.911
4.440	6.313	1.911	4.432	8.107	1.911
4.441	6.370	1.911	4.433	8.184	1.911
4.442	6.427	1.911	4.434	8.261	1.911
4.443	6.484	1.911	4.435	8.338	1.911
4.444	6.541	1.911	4.436	8.415	1.911
4.445	6.598	1.911	4.437	8.492	1.911

Table III (concluded)

Series VII (Caesium Iodide)

$-33.5^{\circ}C$				$-48.5^{\circ}C.$			
No.	log k	log V	Δ	No.	log k	log V	Δ
1	4.797	1.296	12.4	1	4.747	1.288	10.8
2	4.370	1.744	13.0	2	4.326	1.736	11.5
3	4.022	2.193	16.4	3	5.978	2.185	14.6
4	5.708	2.642	22.4	4	5.670	2.634	20.1
5	5.430	3.091	33.2	5	5.384	3.083	29.3

Table III (continued)

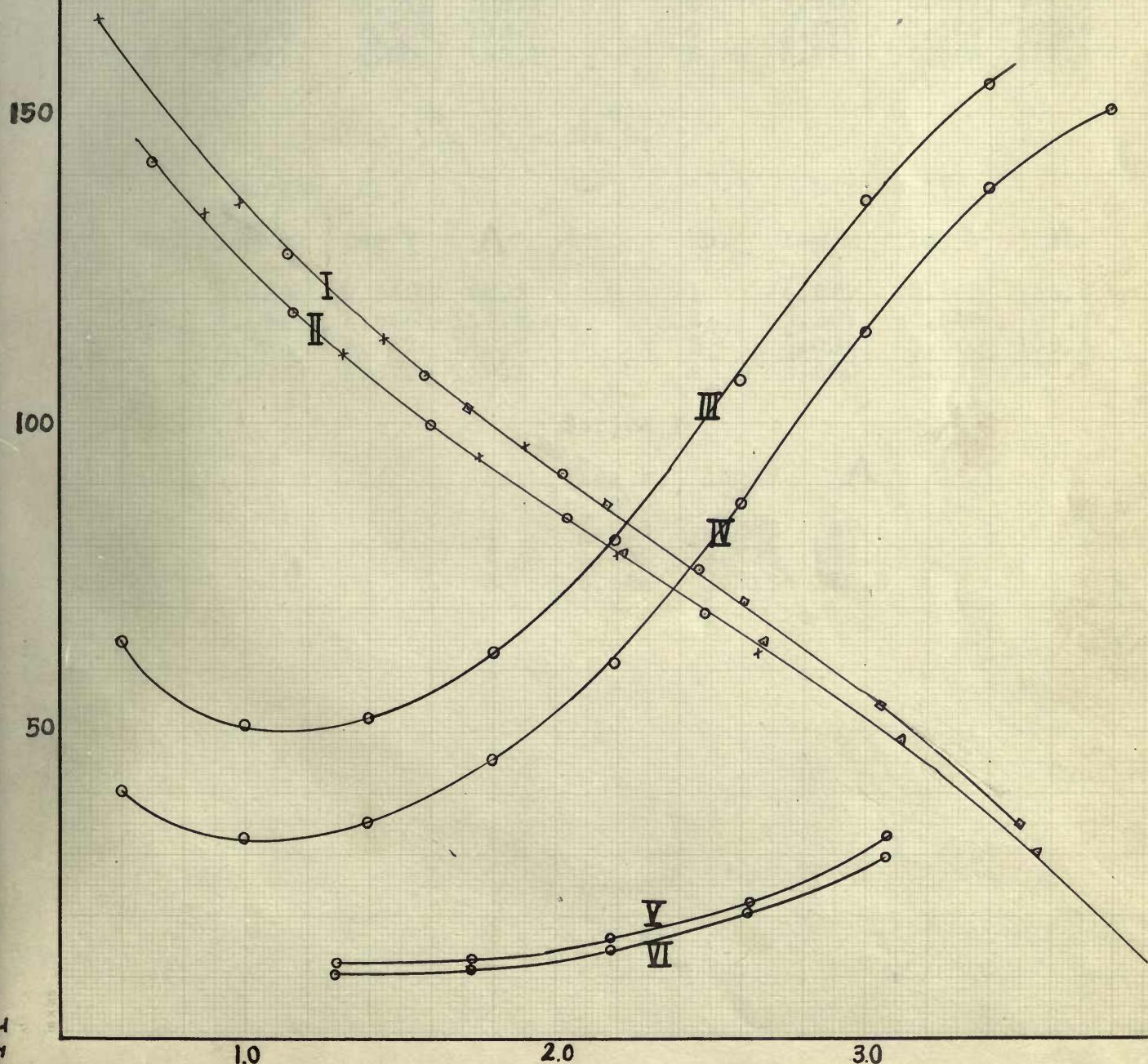
Series AII (assimilate)

Δ	log x	log y	no.	Δ	log x	log y	no.
10.9	8.88	1.15	1	4.74	1.93	1.15	10.9
11.3	8.90	1.14	2	4.74	1.92	1.14	11.3
11.6	8.92	1.13	3	4.74	1.91	1.13	11.6
11.7	8.93	1.12	4	4.74	1.90	1.12	11.7
11.8	8.94	1.11	5	4.74	1.89	1.11	11.8
11.9	8.95	1.10	6	4.74	1.88	1.10	11.9
12.0	8.96	1.09	7	4.74	1.87	1.09	12.0
12.1	8.97	1.08	8	4.74	1.86	1.08	12.1
12.2	8.98	1.07	9	4.74	1.85	1.07	12.2
12.3	8.99	1.06	10	4.74	1.84	1.06	12.3
12.4	9.00	1.05	11	4.74	1.83	1.05	12.4
12.5	9.01	1.04	12	4.74	1.82	1.04	12.5
12.6	9.02	1.03	13	4.74	1.81	1.03	12.6
12.7	9.03	1.02	14	4.74	1.80	1.02	12.7
12.8	9.04	1.01	15	4.74	1.79	1.01	12.8
12.9	9.05	1.00	16	4.74	1.78	1.00	12.9
13.0	9.06	0.99	17	4.74	1.77	0.99	13.0
13.1	9.07	0.98	18	4.74	1.76	0.98	13.1
13.2	9.08	0.97	19	4.74	1.75	0.97	13.2
13.3	9.09	0.96	20	4.74	1.74	0.96	13.3
13.4	9.10	0.95	21	4.74	1.73	0.95	13.4
13.5	9.11	0.94	22	4.74	1.72	0.94	13.5
13.6	9.12	0.93	23	4.74	1.71	0.93	13.6
13.7	9.13	0.92	24	4.74	1.70	0.92	13.7
13.8	9.14	0.91	25	4.74	1.69	0.91	13.8
13.9	9.15	0.90	26	4.74	1.68	0.90	13.9
14.0	9.16	0.89	27	4.74	1.67	0.89	14.0
14.1	9.17	0.88	28	4.74	1.66	0.88	14.1
14.2	9.18	0.87	29	4.74	1.65	0.87	14.2
14.3	9.19	0.86	30	4.74	1.64	0.86	14.3
14.4	9.20	0.85	31	4.74	1.63	0.85	14.4
14.5	9.21	0.84	32	4.74	1.62	0.84	14.5
14.6	9.22	0.83	33	4.74	1.61	0.83	14.6
14.7	9.23	0.82	34	4.74	1.60	0.82	14.7
14.8	9.24	0.81	35	4.74	1.59	0.81	14.8
14.9	9.25	0.80	36	4.74	1.58	0.80	14.9
15.0	9.26	0.79	37	4.74	1.57	0.79	15.0
15.1	9.27	0.78	38	4.74	1.56	0.78	15.1
15.2	9.28	0.77	39	4.74	1.55	0.77	15.2
15.3	9.29	0.76	40	4.74	1.54	0.76	15.3
15.4	9.30	0.75	41	4.74	1.53	0.75	15.4
15.5	9.31	0.74	42	4.74	1.52	0.74	15.5
15.6	9.32	0.73	43	4.74	1.51	0.73	15.6
15.7	9.33	0.72	44	4.74	1.50	0.72	15.7
15.8	9.34	0.71	45	4.74	1.49	0.71	15.8
15.9	9.35	0.70	46	4.74	1.48	0.70	15.9
16.0	9.36	0.69	47	4.74	1.47	0.69	16.0
16.1	9.37	0.68	48	4.74	1.46	0.68	16.1
16.2	9.38	0.67	49	4.74	1.45	0.67	16.2
16.3	9.39	0.66	50	4.74	1.44	0.66	16.3
16.4	9.40	0.65	51	4.74	1.43	0.65	16.4
16.5	9.41	0.64	52	4.74	1.42	0.64	16.5
16.6	9.42	0.63	53	4.74	1.41	0.63	16.6
16.7	9.43	0.62	54	4.74	1.40	0.62	16.7
16.8	9.44	0.61	55	4.74	1.39	0.61	16.8
16.9	9.45	0.60	56	4.74	1.38	0.60	16.9
17.0	9.46	0.59	57	4.74	1.37	0.59	17.0
17.1	9.47	0.58	58	4.74	1.36	0.58	17.1
17.2	9.48	0.57	59	4.74	1.35	0.57	17.2
17.3	9.49	0.56	60	4.74	1.34	0.56	17.3
17.4	9.50	0.55	61	4.74	1.33	0.55	17.4
17.5	9.51	0.54	62	4.74	1.32	0.54	17.5
17.6	9.52	0.53	63	4.74	1.31	0.53	17.6
17.7	9.53	0.52	64	4.74	1.30	0.52	17.7
17.8	9.54	0.51	65	4.74	1.29	0.51	17.8
17.9	9.55	0.50	66	4.74	1.28	0.50	17.9
18.0	9.56	0.49	67	4.74	1.27	0.49	18.0
18.1	9.57	0.48	68	4.74	1.26	0.48	18.1
18.2	9.58	0.47	69	4.74	1.25	0.47	18.2
18.3	9.59	0.46	70	4.74	1.24	0.46	18.3
18.4	9.60	0.45	71	4.74	1.23	0.45	18.4
18.5	9.61	0.44	72	4.74	1.22	0.44	18.5
18.6	9.62	0.43	73	4.74	1.21	0.43	18.6
18.7	9.63	0.42	74	4.74	1.20	0.42	18.7
18.8	9.64	0.41	75	4.74	1.19	0.41	18.8
18.9	9.65	0.40	76	4.74	1.18	0.40	18.9
19.0	9.66	0.39	77	4.74	1.17	0.39	19.0
19.1	9.67	0.38	78	4.74	1.16	0.38	19.1
19.2	9.68	0.37	79	4.74	1.15	0.37	19.2
19.3	9.69	0.36	80	4.74	1.14	0.36	19.3
19.4	9.70	0.35	81	4.74	1.13	0.35	19.4
19.5	9.71	0.34	82	4.74	1.12	0.34	19.5
19.6	9.72	0.33	83	4.74	1.11	0.33	19.6
19.7	9.73	0.32	84	4.74	1.10	0.32	19.7
19.8	9.74	0.31	85	4.74	1.09	0.31	19.8
19.9	9.75	0.30	86	4.74	1.08	0.30	19.9
20.0	9.76	0.29	87	4.74	1.07	0.29	20.0
20.1	9.77	0.28	88	4.74	1.06	0.28	20.1
20.2	9.78	0.27	89	4.74	1.05	0.27	20.2
20.3	9.79	0.26	90	4.74	1.04	0.26	20.3
20.4	9.80	0.25	91	4.74	1.03	0.25	20.4
20.5	9.81	0.24	92	4.74	1.02	0.24	20.5
20.6	9.82	0.23	93	4.74	1.01	0.23	20.6
20.7	9.83	0.22	94	4.74	1.00	0.22	20.7
20.8	9.84	0.21	95	4.74	0.99	0.21	20.8
20.9	9.85	0.20	96	4.74	0.98	0.20	20.9
21.0	9.86	0.19	97	4.74	0.97	0.19	21.0
21.1	9.87	0.18	98	4.74	0.96	0.18	21.1
21.2	9.88	0.17	99	4.74	0.95	0.17	21.2
21.3	9.89	0.16	100	4.74	0.94	0.16	21.3
21.4	9.90	0.15	101	4.74	0.93	0.15	21.4
21.5	9.91	0.14	102	4.74	0.92	0.14	21.5
21.6	9.92	0.13	103	4.74	0.91	0.13	21.6
21.7	9.93	0.12	104	4.74	0.90	0.12	21.7
21.8	9.94	0.11	105	4.74	0.89	0.11	21.8
21.9	9.95	0.10	106	4.74	0.88	0.10	21.9
22.0	9.96	0.09	107	4.74	0.87	0.09	22.0
22.1	9.97	0.08	108	4.74	0.86	0.08	22.1
22.2	9.98	0.07	109	4.74	0.85	0.07	22.2
22.3	9.99	0.06	110	4.74	0.84	0.06	22.3
22.4	10.00	0.05	111	4.74	0.83	0.05	22.4
22.5	10.01	0.04	112	4.74	0.82	0.04	22.5
22.6	10.02	0.03	113	4.74	0.81	0.03	22.6
22.7	10.03	0.02	114	4.74	0.80	0.02	22.7
22.8	10.04	0.01	115	4.74	0.79	0.01	22.8
22.9	10.05	-0.01	116	4.74	0.78	-0.01	22.9
23.0	10.06	-0.02	117	4.74	0.77	-0.02	23.0
23.1	10.07	-0.03	118	4.74	0.76	-0.03	23.1
23.2	10.08	-0.04	119	4.74	0.75	-0.04	23.2
23.3	10.09	-0.05	120	4.74	0.74	-0.05	23.3
23.4	10.10	-0.06	121	4.74	0.73	-0.06	23.4
23.5	10.11	-0.07	122	4.74	0.72	-0.07	23.5
23.6	10.12	-0.08	123	4.74	0.71	-0.08	23.6
23.7	10.13	-0.09	124	4.74	0.70	-0.09	23.7
23.8	10.14	-0.10	125	4.74	0.69	-0.10	23.8
23.9	10.15	-0.11	126	4.74	0.68	-0.11	23.9
24.0	10.16	-0.12	127	4.74	0.67	-0.12	24.0
24.1	10.17	-0.13	128	4.74	0.66	-0.13	24.1
24.2	10.18	-0.14	129	4.74	0.65	-0.14	24.2
24.3	10.19	-0.15	130	4.74	0.64	-0.15	24.3
24.4	10.20	-0.16	131	4.74	0.63	-0.16	24.4
24.5	10.21	-0.17	132	4.74	0.62	-0.17	24.5
24.6	10.22	-0.18	133	4.74	0.61	-0.18	24.6
24.7	10.23	-0.19	134	4.74	0.60	-0.19	24.7
24.8	10.24	-0.20	135	4.74	0.59	-0.20	24.8
24.9	10.25	-0.21	136	4.74	0.58	-0.21	24.9
25.0	10.26	-0.22	137	4.74	0.57	-0.22	25.0
25.1	10.27	-0.23	138	4.74	0.56	-0.23	25.1
25.2	10.28	-0.24	139	4.74	0.55	-0.24	25.2
25.3	10.29	-0.25	140	4.74	0.54	-0.25	25.3
25.4	10.30	-0.26	141	4.74	0.53	-0.26	25.4
25.5	10.31	-0.27	142	4.74	0.52	-0.27	25.5
25.6	10.32	-0.28	143	4.74	0.51	-0.28	25.6
25.7	10.33	-0.29	144	4.74	0.50	-0.29	25.7
25.8	10.34	-0.30	145	4.74	0.49	-0.30	25.8
25.9	10.35	-0.31	146	4.74	0.48	-0.31	25.9
26.0	10.36	-0.32	147	4.74	0.47	-0.32	26.0
26.1	10.37	-0.33	148	4.74	0.46	-0.33	26.1
26.2	10.38	-0.34	149	4.74	0.45	-0.34	26.2
26.3	10.39	-0.35	150	4.74	0.44	-0.35	26.3
26.4	10.40	-0.36	151	4.74	0.43	-0.36	26.4
26.5	10.41	-0.37	152	4.74	0.42	-0.37	26.5
26.6	10.42	-0.38	153	4.74	0.41	-0.38	26.6
26.7	10.43	-0.39	154	4.74	0.40	-0.39	26.7
26.8	10.44	-0.40	155	4.74	0.39	-0.40	26.8
26.9	10.45	-0.41	156</td				

Fig. 5.

C_s in CH₃NH₂

I - 33.5°C. ; II - 48.5°C.



Log V

Fig. 1

K in CH_3NH_2

I -33.5°C II -48.5°C

Table IV

Conductance of Potassium in Methylamine
 -48.5°C .

Series I

No.	log k	log V	Λ
1	4.394	2.408	63.4
2	4.049	2.869	82.8
3	5.721	3.314	108.4
4	5.366	3.758	133.1
5	6.891	4.201	152.1

Series II

No.	log k	log V	Λ
1	4.592	2.088	47.9
2	4.269	2.534	63.6
3	5.940	2.977	82.6
4	5.590	3.425	103.6
5	5.229	3.868	125.1

 -33.5°C .

Series III

No.	log k	log V	Λ
1	4.426	2.542	92.9
2	4.096	2.984	117.5
3	5.726	3.427	142.3
4	5.303	3.870	149.1

Series IV

No.	log k	log V	Λ
1	4.679	2.143	66.4
2	4.357	2.586	87.7
3	4.009	3.030	109.4
4	5.640	3.476	130.7

Series V

No.	log k	log V	Λ
1	4.514	2.328	69.6
2	4.250	2.773	105.5
3	5.884	3.218	126.5

Uebersicht

organization at his station to corroborate

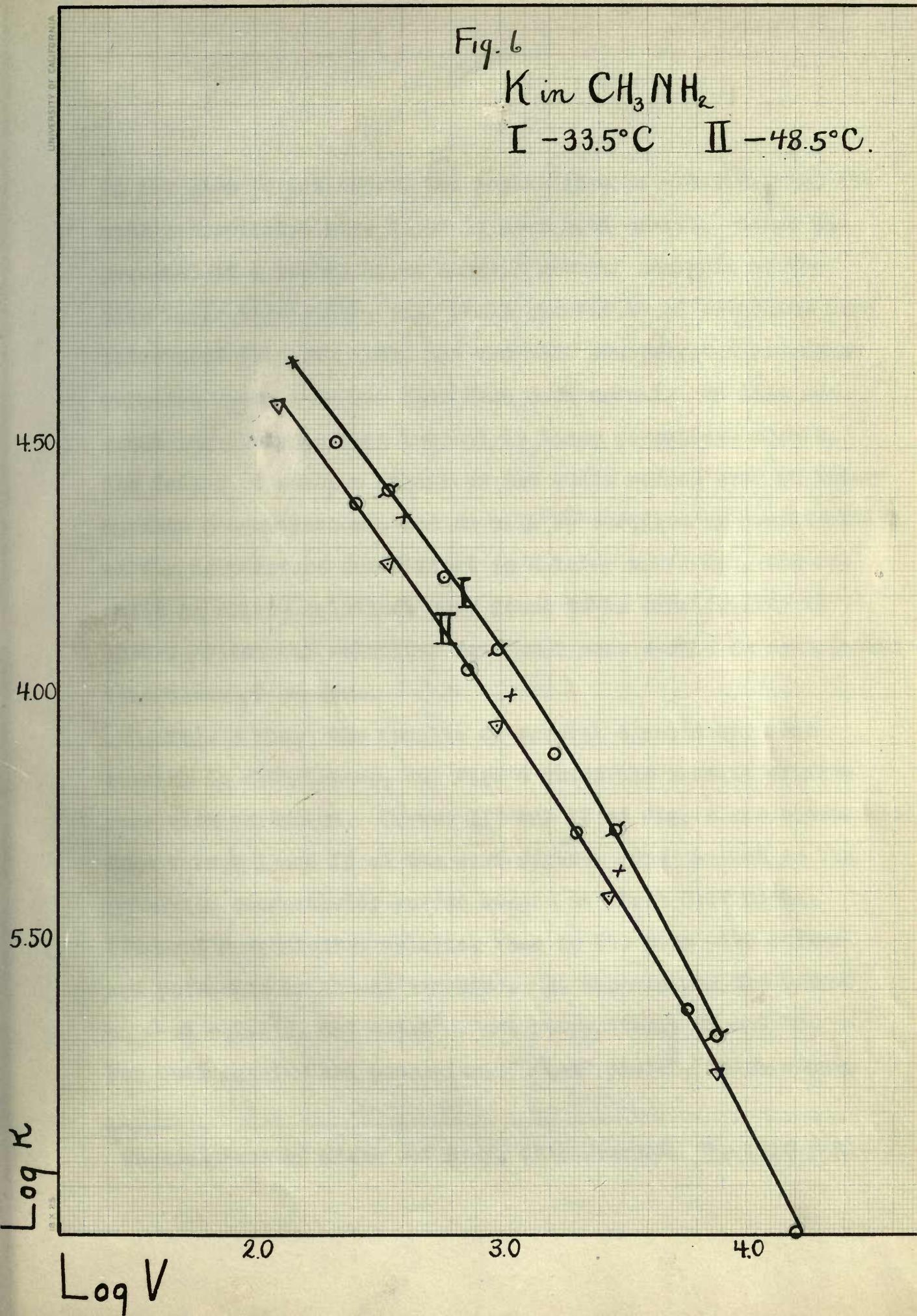
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V. *Science*

A	Top A	Top B	Top C	Top D
8.89	888	8.888	8.888	8.888
8.89	888	8.888	8.888	8.888
8.89	888	8.888	8.888	8.888
8.89	888	8.888	8.888	8.888

Fig. 6

 K in CH_3NH_2 I $-33.5^{\circ}C$ II $-48.5^{\circ}C$.

In the case of potassium, two layers form at $-33.5^{\circ}\text{C}.$, and the most concentrated blue layer is near 0.01 normal. Since the presence of a bronze layer makes a correct analysis of the blue layer impossible, only small quantities of potassium were introduced into the cell, and the most concentrated potassium solution determined was less than 0.01 normal. On this account the analyses were subject to large percentage errors. The fading of caesium solutions was quite marked even at intermediate concentrations, and as will be verified by consideration of the temperature coefficient in a later paragraph, the results in dilute solutions were found to be considerably in error. Potassium solutions were much more stable in methylamine than those of caesium.

Fig. 3 shows the results of several experiments with caesium in methylamine, and Fig. 4 shows the results of five runs with potassium. Curves III and IV of Fig. 3 are constructed from Curves I and II of the same figure. The minimum in the molecular conductivity curves occurs at about 0.07 normal (in more concentrated solution than is the case with sodium and potassium in liquid ammonia). At the minimum the values of Δ at $-33.5^{\circ}\text{C}.$ and $-48.5^{\circ}\text{C}.$ are respectively 51 and 33. For both caesium and potassium, " Δ - k " plots¹, which assume

¹

Nomenclature of Kraus and Bray, This Journal, 35, 1315 (1913).

10.00- to much energy and motivation to move out at
mid night . between 10.00 and 11.00 am the following day
out to exercise twice a week will assist in the recovery
and motivation to continue this adolescent year and
making better choices than out here . This out of the best part
of night is . Between 10.00 and 11.00 am the best part
of the day is the best part of the day even though out here
out to move around after a long night of getting up
and moving up and down in the middle of the night , which makes it
exceedingly hard to get up and get out of bed to
do what needs to be done and make the most of the
day out of the best part of the day even though out here
out to move around after a long night of getting up
and moving up and down in the middle of the night .

After a long night out here the first part of the day is
out to move around after a long night of getting up and
moving up and down in the middle of the night , which makes it
exceedingly hard to get up and get out of bed to
do what needs to be done and make the most of the
day out of the best part of the day even though out here
out to move around after a long night of getting up
and moving up and down in the middle of the night .
Between 10.00 and 11.00 am the best part of the day even though out here
out to move around after a long night of getting up and
moving up and down in the middle of the night , which makes it
exceedingly hard to get up and get out of bed to
do what needs to be done and make the most of the
day out of the best part of the day even though out here
out to move around after a long night of getting up and
moving up and down in the middle of the night .

the validity of the mass law, were constructed, and led to the following values:

Temp.	Metal	k(mass law const.)
-33.5	K	159×10^{-4}
-48.5	K	144×10^{-4}
-33.5	Ca	188×10^{-4}
-48.5	Ca	174×10^{-4}

A single run was also made with caesium iodide¹ in methylamine, and the results of this experiment appear in Fig. 3, Curves V and VI. The position of these curves is substantially the same as that for potassium iodide in methylamine given by Franklin and Gibbs². "A.-k" plots for caesium iodide led to the following values:

Temp.	k(mass law const.)
-33.5	60.6×10^{-4}
-48.5	56.2×10^{-4}

Discussion of Results.

The true temperature coefficient in dilute solutions is independent of temperature. In Table V of his recent article

¹ Caesium chloride was found to be insoluble.

² Franklin and Gibbs, This Journal 29, 1391 (1907).

at Def. Ans. Defensives eren, wel' oben mit Die Waffen und
Waffen gewaffnet

<u>(.76200 maf. Geweh)</u>	<u>Defekt</u>	<u>Wert</u>
<u>4-01 X 5.15</u>	<u>901</u>	<u>2</u>
<u>4-01 X 5.15</u>	<u>901</u>	<u>2</u>
<u>4-01 X 5.15</u>	<u>901</u>	<u>2</u>
<u>4-01 X 5.15</u>	<u>901</u>	<u>2</u>

Item 41 obige Waffen habe zu ver kaufen und
2 Stück zu zweig Deutsch mark zu verkaufen die hier beschriebene
Waffen ni verkaufen sofort zu verboten ist .IV Am V verbot
hier beschriebene ni obige Waffen zu verkaufen und hier obige Waffen zu
verkaufen gewollt ist

<u>(.76200 maf. Geweh)</u>	<u>Wert</u>
<u>4-01 X 50.1</u>	<u>2.00</u>
<u>4-01 X 50.1</u>	<u>2.00</u>

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(4001) 4001 4001 4001 4001 4001 4001 4001 4001

upon conductance in liquid ammonia¹, Kraus calculates values for $\Delta(1/R)/\Delta t(1/R_{33}) \times 100$, and this quantity increases rapidly with temperature. Evidence that the true temperature coefficient $d(\ln k)/dt$ is independent of temperature in dilute solutions is presented in Fig. 3. The three upper points are values for $\log R$ taken from Fig. 2 at 0.004 normal, and moved along the $\log R$ axis until the value at -33.5°C agrees with that of Kraus. The five lower points are Kraus's values for $\log R$ in "dilute solution" over a higher range of temperature. Weight is given to the points at the lower temperature where the fading was less. A straight line seems to be justified, since the aberration of the points at the higher temperatures is in the direction to be expected from fading.

At concentrations near the minimum there was evidence of a larger temperature coefficient at the higher temperature in the case of both sodium and potassium, but the effect was scarcely beyond the limit of experimental error, and could not be established with certainty.

In Table V is a summary of temperature coefficients calculated from the $\log k$ curves in the preceding figures. The values of $d(\log k)$ were taken directly from the plots. In the

1

Loc. cit.

Last column of Table V gives the values of $d(\ln k)/dt$ at

Table V
Summary of Temperature Coefficients

Log V	Temp. Range	Solute	Solvent	$d(\ln k)/dt$	Average
1.4	-53 to -48	Na	NH_3	20.9	20.4
2.4	"	"	"	20.7	
1.4	-48 to -70	"	"	18.6	20.4
2.4	"	"	"	21.6	
1.4	-53 to -48	K	NH_3	27.4	29.1
2.4	"	"	"	30.7	
2.0	-53 to -48	K	CH_5NH_2	20.6	19.8
3.0	"	"	"	19.0	
1.0	-53 to -48	Cs	CH_5NH_2	27.6	23.9
2.0	"	"	"	20.3	
3.0	"	"	"	9.2 (fading)	
1.3 - 3.0	"	CsI	CH_5NH_2	7.7	7.7

where ϕ is the density, and a and b are constants, appear to be generally applicable. The values of a are usually very nearly unity. Hydrogen and halogen ions are again excepted.

Kolthaus and Hollens, *Der Elektrolyten und Elektrolytische*, (Lehrbuch, Leipzig and Berlin, 1926).

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оговора, то \{ст. 65\} оно не является оценкой, а значит, оно не подпадает под действие \{ст. 65\}.

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0.00	200	00	00- 00 00+	0.0
0.00	00	00	00- 00 00+	0.0
0.00	00	00	00- 00 00+	0.0
0.00	00	00	00- 00 00+	0.0

《水經》云：「江水又东迳武昌西，又东迳夏口，入海。」

$$\left\{ \begin{array}{cccccc} 0.62 & 0.62 & 2 & 20-67.22- & 0.8 \\ 0.61 & * & 4 & " & 0.7 \end{array} \right.$$

$$6.53 \quad \left\{ \begin{array}{lllll} 3.73 & 30.80 & 1.36 & 82.07 & 33.7 \\ 3.05 & " & " & " & 0.9 \end{array} \right.$$

0.8

197 198 199 200 201

last column of Table V appear the values of $d(\ln k)/dt$ at one or more dilutions for each solute, and also an average value for each solute.

The temperature coefficients are about the same in the two solvents. The rapid decline in the temperature coefficient of caesium in methylamine is ascribed to fading. For a 0.001 normal potassium solution, in which the fading was much slower, the temperature coefficient is still 19×10^{-3} , whereas at the same dilution in a caesium solution the value has fallen to 9×10^{-3} .

It has been pointed out by Kohlrausch¹ that the temperature coefficients of conductivity and viscosity in aqueous solutions of most salts are approximately the same. Hydrogen and hydroxyl ions are exceptions to this rule, the temperature coefficients of conductivity being abnormally low. Johnston² studied the relationship between viscosity and conductivity over a wide range of temperature in water and in non-aqueous solvents, and showed that the equation,

$$\Delta = k\phi^m,$$

where ϕ is the fluidity, and m and k are constants, appears to be generally applicable. The value of m is usually very nearly unity. Hydrogen and hydroxyl ions are again exceptional.

¹

Kohlrausch und Holborn, *Das Leitvermögen der Elektrolyte*, p. 127.
(Teubner, Leipzig und Berlin, 1916)

²

This Journal, 31, 1010 (1909).

εποντα, απότομος είναι ο τόπος γενίστικης εδώ στη φράση
την οποίαν είναι το ακίνητο της πεδινής γενίστικης εδώ στη φράση
την οποίαν είναι το ακίνητο της πεδινής γενίστικης εδώ στη φράση

We may remark in passing that the low value of the temperature coefficient of conductivity of these ions might be accounted for if we assume the conductivity to be due in part to the liberation of a hydrogen or a hydroxyl ion at one end of a chain of water molecules, and a simultaneous binding of a hydrogen or a hydroxyl ion at the other end of the chain, without actual migration of the ions through the solution, as has been suggested by various authors¹ to account for the abnormally high conductance of these solutions. For, if we assume such chains of water molecules to become less stable at the higher temperatures, the diminution in this type of conduction would counteract the increase due to the diminishing viscosity of the solution, and thus give an abnormally low temperature coefficient. If we assume the rule of Kohlrausch to hold for methylamine, the temperature coefficient of the conductivity of all salts in this solvent should be approximately equal to that of caesium iodide. If this is true, the temperature coefficient of conductivity of the alkali metals in methylamine is abnormally high. This could be accounted for by a decreased solvation of the electrons with rise in temperature, - as was assumed by Gibson and Argo² as a possible explanation of the

1

Lewis, This Journal, 34, 1642 (1912);
Latimer and Nodobush, Ibid., 42, 1452 (1920).

2

The conductivity rises very rapidly as the concentration is increased. The relation is approximately the same for

diminution in the coefficient of absorption of these solutions with increasing temperature.

In order to account for the deviation from Beer's Law for the shorter wave-lengths in solutions of the alkali metals in methylamine, Gibson and Argo assumed the absorption at these wave-lengths to be partly due to unionized metal. Since the solutions in ammonia do not show this deviation from Beer's Law, they assumed the ionization in ammonia to be more complete than in methylamine. The dissociation constant for the metals in ammonia is greater than that in methylamine, but the difference is hardly sufficient to account for the deviations which they observed. The deviation from Beer's Law may nevertheless be due to unionized metal, for the absorption due to unionized metal in ammonia may not be in the visible spectrum. This point could not be decided without a knowledge of the absorption curve in ammonia at other wave-lengths.

We have already mentioned that the conductivity curves of the metals in ammonia and in methylamine are of the same general type, the conductivity diminishing at first according to the mass law in dilute solutions, becoming greater than would be predicted from the mass law in more concentrated solutions, until a minimum in the conductivity is reached, after which the conductivity rises very rapidly as the concentration is further increased. The minimum is approximately the same for

all the metals in any one solvent, but occurs at a somewhat lower concentration in ammonia than in methylamine. If we assume the increase in conductivity to the higher concentrations to be due to the influence of free ions in the solution, which cause a diminution in the electrical forces, - for much the same reason that an increase in the dielectric constant would cause a diminution in these forces, - we should expect a deviation from the mass law to occur at lower concentrations in a solution which is highly ionized than in one which is less so. We have seen that the metals are more highly ionized in ammonia than in methylamine; hence the solutions in ammonia, other things being equal, should show a minimum at lower concentrations than those in methylamine, as is actually observed. The extreme rapidity of the increase in conductivity at concentrations beyond the minimum points to a rapid diminution in the solvation of the electrons as the concentration is increased. This would seem to indicate that the force binding the electron to the solvent is electrical in character, and is diminished in concentrated solutions for the same reason that the ionization of the metal is increased, - namely owing to a diminution in the electrical forces due to the presence of free ions in the solution.

A certain amount of support for the assumption that the

attraction between the electron and the solvent is electrical in character is given by the fact that the absorption maximum in methylamine occurs at a shorter wave-length than in ammonia. In the latter solvent the measurements of Gibson and Argo¹ appear to indicate an absorption maximum in the infra-red. The dielectric constant of ammonia is greater than that of methylamine and we should therefore expect the electron to be less firmly bound in ammonia than in methylamine if the binding force is electrical in character. Determinations of the absorption maxima of lithium in ethylamine and propylamine, and a determination of the dielectric constants of these solvents should throw light on this question.



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